

1 housing, the antenna output signal 60 is freely transmitted through  
2 plastic cap 44 into the surrounding atmosphere, and reaches the  
3 operator's cab 12, where it is received by receiver 62.

4 [34] As shown in Fig. 7, the operator's cab is equipped with  
5 various alarm devices 65, both visual and aural, to inform the  
6 operator that an adapter is breaking loose. If loss of the adapter  
7 cannot be stopped, its tooth will go with it to the ore crusher.

8 MODIFIED AND ALTERNATIVE FORMS

9 [35] It is not essential that the transmitter of each alarm  
10 unit be constructed integral with the associated mechanical part.  
11 Various kinds of electromechanical or electromagnetic transducers  
12 may be used to carry out the concept of the invention.

13 [36] While we have disclosed the presently preferred  
14 embodiment of our invention in detail in order to comply with the  
15 requirements of the patent laws, it is to be understood that the  
16 scope of the invention and the protection herein sought is to be  
determined only in accordance with the appended claims.

WHAT WE CLAIM IS:

1           1. The method of preventing the unexpected loss of heavy  
2 mining equipment in which one metal part of the equipment may  
3 become separated from another metal part, by mechanically detecting  
4 the separation of the metal parts at an early stage in the  
5 separation process, generating a radio signal in response to such  
6 mechanical detection, receiving the radio signal at another  
7 location, and then in response to reception of the radio signal  
generating a warning signal.

1           2. The method of preventing damage from the loss of heavy  
2 mining equipment that is unexpectedly separated from a heavy mining  
3 machine, comprising the steps of:

4           selecting a monitoring station associated with the mining  
5 machine;

6           positioning a radio receiver at the monitoring station;

7           selecting an electromechanical transducer that is adapted to  
8 respond to physical separation of the equipment from the machine;

9           placing a radio transmitter in operative relationship to the  
10 transducer;

11          positioning the transducer and its associated transmitter in  
12 a location suitable for generating a signal from the transmitter  
13 whenever the heavy equipment has been at least partially separated  
14 from the machine; and

15          whenever a signal is received at the monitoring station,  
16 generating an alarm with sufficient promptness that the further  
17 separation of the equipment from the machine may be stopped in time  
to prevent substantial damage from occurring.

1           3. In an open-pit mining operation in which ore is dug by a  
2 machine having a bucket with large tooth structures, in batches so  
3 large that an operator cannot by visual inspection determine their  
4 content, the method of preventing a tooth structure that is being  
5 unexpectedly separated from its bucket from being caught up in the  
6 ore and transported into an ore crusher along with the ore and  
7 thereby damaging the crusher, comprising the steps of:

8           selecting a monitoring station associated with the machine;

9           positioning a radio receiver at the monitoring station;

10          selecting an electromechanical transducer adapted to respond  
11 to physical separation of the tooth structure from its bucket;

12          placing a radio transmitter in operative relationship to the  
13 transducer;

14          positioning the transducer and its associated transmitter in  
15 a location for generating a signal from the transmitter whenever  
16 the tooth structure has been at least partially separated from the  
17 bucket; and

18          whenever a signal is received at the monitoring station,  
19 generating an alarm with sufficient promptness that the further  
20 separation of the tooth structure may be stopped in time to prevent  
the tooth structure from being caught up in the crusher.

4. The method of Claim 3 wherein the positions of the  
transmitter and receiver are chosen such that a signal may be  
successfully sent from the transmitter to the receiver even before  
a partial separation of the tooth structure has occurred.

1           5. Mining shovel apparatus comprising, in combination:

2           a mining machine having a large bucket operatively driven and  
3 controlled by the machine, the bucket having a leading edge;

4           a plurality of tooth adapters carried on the leading edge of  
5 the bucket, each tooth adapter being removably attached to the  
6 bucket leading edge;

7           a plurality of teeth, one for each tooth adapter, each tooth  
8 being removably attached to a respectively corresponding adapter;

9           a plurality of electromechanical transducers, each transducer  
10 being cooperatively associated with both a corresponding one of the  
11 adapters and its respectively associated tooth;

12           a plurality of radio transmitters, each being in operative  
13 relationship to a corresponding transducer;

14           a monitoring station associated with the mining machine;

15           a radio receiver positioned at the monitoring station;

16           each transducer being adapted to cause the associated  
17 transmitter to generate a signal whenever the associated tooth  
18 adapter is at least partially separated from the leading edge of  
19 the bucket; and

20           the monitoring station having associated means responsive to  
21 a signal received from any one of the transmitters for generating  
22 an alarm with sufficient promptness that the further separation of  
23 the adapter may be stopped in time to prevent the adapter and its  
associated tooth from being caught up in the crusher.

6. The mining shovel apparatus of Claim 5 wherein at least certain ones of the transducers include a pressure-sensitive switch positioned between interengaging surfaces of the associated adapter and the leading edge of the bucket; the switch then being operative in response to relative movement of the interengaging surfaces to active the associated transmitter.

7. A transducer in accordance with Claim 6 which includes a housing recessed in one of the interengaging surfaces, a plunger normally positioned within the housing, and a spring inside the housing adapted to drive the plunger outward whenever separation of the interengaging surfaces starts to occur.

1           8. In a mining machine having two metal parts that normally  
2 remain in surface contact during operation of the machine, an  
3 electromechanical transducer mechanism for generating an alarm  
4 whenever one of the metal parts moves away from the other,  
5 comprising:

6           a recess in the surface of one of the metal parts;

7           a printed circuit board dividing the interior of the recess  
8 into a battery compartment and a plunger compartment;

9           a battery in the battery compartment;

10          an antenna circuit wired onto the circuit board;

11          a switch installed in the printed circuit board and wired to  
12 the battery;

13          a cylindrical plunger slidably received within the outer end  
14 of the plunger compartment, having an outer end normally engaging  
15 a surface of the other metal part;

16          a coil spring beneath the plunger; and

17          a magnet positioned between the coil spring and the plunger;

18          the operation being such that release of pressure on the outer  
19 end of the plunger allows the spring to drive the magnet and the  
20 plunger outward, and the movement of the magnet closes the switch  
so as to actuate the antenna and cause it to transmit a signal.

9. A transducer mechanism as in Claim 8 wherein a steel can is received within the recess, an aluminum can is removably positioned within the steel can, and the antenna circuit is wired onto the side wall of the circuit board that faces toward the plunger compartment.

10. A transducer mechanism as in Claim 8 having a plunger housing made of aluminum in the form of an elongated cylinder with a small cylindrical opening in its outer end and a large cylindrical opening in its inner end, the plunger being slidably received within the outer end of the housing.

11. A transducer mechanism as in Claim 9 having a plunger housing made of aluminum in the form of an elongated cylinder with a small cylindrical opening in its outer end and a large cylindrical opening in its inner end, the plunger being slidably received within the outer end of the housing.

12. In an open-pit mining operation, the method of detecting the partial separation of large metal parts of a mining machine, in which a spring-loaded switch is sandwiched between the parts, the switch being adapted to then expand upon partial separation of the parts to turn on an electrical switch and activate an associated radio transmitter.

13. A mechanism for detecting the separation of two members that are normally in abutting engagement, comprising:

a recess in the surface of one of the members;

a spring-loaded plunger having an inner end extending into the recess, and an outer end normally engaging the other member;

electromagnetic means for detecting movement of the plunger, and

electrical transmitting means selectively actuated by the electromagnetic detection means.